SCIENCE

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

ILLUSTRATED.

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JOHN MICHELS, Editor.

PUBLISHED AT

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P. O. Box 3838.

SATURDAY, MAY 7, 1881.

Dr. H. J. Detmers, of Chicago, has forwarded to us a communication of considerable importance, which will doubtless be read with interest both on this continent and in Europe.

In 1877 the Commissioner of Agriculture reported that during the previous year, the loss due to farm animals dying from infectious and contagious diseases amounted to $16,653,428, of which amount two-thirds, or over $11,000,000, were due to loss of swine. But as this report included returns from only half of the United States, the above sum was, of course, far below the actual losses of the year.

Congress having appropriated $10,000 for defraying the expenses of a commission to investigate the causes which produced these contagious and destructive diseases, and, if possible, to discover remedies, the matter was placed in various hands to conduct the inquiry.

Among those who have received instructions from the Department of Agriculture, Dr. H. J. Detmers has shown considerable skill in attacking the problem, and the results of his work have developed several discoveries of great biological significance.

Although working with inferior microscopical appliances, he soon found that a particular kind of Bacterium was always present in cases of swine plague, and he has been able, apparently, to prove by actual experiment that these Bacteria were the active principle of contagion.

The early investigations of Dr. Detmers were given in the Report of the Agricultural Department for 1878. Since this time Dr. Detmers has, with considerable industry, continued his investigations under more favorable circumstances; for armed with new objectives made by Mr. Tolles, of Boston, with powers of definition equal to anything yet manufactured to aid human vision, a new revelation has resulted from their use.

The latest discoveries of Dr. Detmers we are able to place before our readers in another column of this issue. Possibly the conclusions drawn in this paper may be criticised, and our columns will be open to any exceptions taken on scientific grounds, but our readers must unite in giving credit to Dr. Detmers for the very thorough and exhaustive treatment which this subject has received at his hands.

The researches of Pasteur in a somewhat similar direction, which have been reported in this journal, suggest to us that Dr. Detmers should, like Pasteur, endeavor to arrest the spread of Hog Cholera by a system of vaccination. Dr. Detmers shows in his present paper that by cultivating the Bacterian infecting element, a contagious principle is secured which by inoculation produces a very mild form of the disease. Could not advantage be taken of this fact in the direction we have indicated?

We are glad to announce that Hog Cholera is rapidly becoming a thing of the past, and has decreased since 1878 so rapidly that at the present time *it is difficult to obtain badly infected specimens* for scientific experimental purposes. This fact, which is communicated to us by Dr. Detmers in a private letter, will be welcome news to those interested in this extensive industry and to the public generally. In Dr. Detmer's report, which we publish this day, it should be noticed that he states that in 1878 the malignant or fatal form (with ulcerous tumors) was found in about 75 *per cent.* of all fatal cases (in Illinois), whereas now their occurrence is probably limited to about 5 *per cent. of all* cases.

Thus the Swine-plague is now under control and is rapidly disappearing. These results are clearly due to the wise policy of publicly making known the evil and the danger, and promptly taking precautionary measures. Let the credit then be given where it is due, even if extended to that much abused Department of Agriculture at Washington, which first raised a voice of warning and secured funds from Congress to "investigate and determine the causes, and if possible *to discover remedies*" of one of the most destructive diseases that ever assailed domestic animals.

Of the Trichinæ trouble we have but a few words to offer, as it can be more profitably described without reference to other subjects. We may, however, observe that it is one of the least formidable of diseases found in hogs, and can probably be eradicated, if proper measures are taken. It is useless to assert that it does not exist, and the only common sense view of the case to be taken, is to acknowledge the evil and root it out. Action should be taken by Boards of Trade to at once gather statistics by proper examinations. If, as they assert, there are no Trichinæ in Ameri-

can hogs, the fact will be demonstrated; if, on the contrary, Trichinæ are found, the extent of the trouble will be known and steps can be taken to protect the industry by systematic examination. We believe that the presence of Trichinæ in pigs is confined to certain districts; if so, it can be localized, and the work of investigation gradually reduced within certain limits, and eventually, by proper precautions, the evil would be entirely removed.

MOUNTAIN ELEVATION, AND CHANGES OF TEMPERATURE, IN GEOLOGY.

By Samuel J. Wallace.

It seems a very little thing for heat and cold to play over the face of a continent. But light and unnoticed as the creeping of fate it goes on forever; and the foundations of the everlasting hills are in its iron grasp. Cold and heat. What should a rock-ribbed continent care for them? What do they do?

In latitude 40° to 50° a yearly change of ten degrees of heat penetrates the upper strata to considerable depths; and the expansion of various kinds of stone for 10° varies from one to three feet in twelve thousand; making, say, one foot to the mile, which across North America is half a mile.

This is an always recurring and resistless force of outward thrust. It is probably mostly compensated for in its habitual recurrence by elasticity, slippages of strata on others, and by fissures; as well as by the fact that the expansion of solid strata is sometimes less from the deep drift or soil protecting them. But, still, as the superior force is outward, without anything to compel a full return in winter, and as the expansion is less below and greater above, the continued tendency is to push the upper strata forward over others toward the margins of extended plains, with a creeping motion, tending to force up bendings, folds and faults, and to raise mountains and plateaus slowly; and even to accumulate such strain or tension as to cause earthquakes and volcanos.

Though, as Dana and others think, there has been a singular persistence in the general features of deep oceans and of continental tables, yet, great portions of the tabular areas have had their depressions and upheavals from the sea. What must have occurred in such cases?

If a tract of sea-bed is covered by an arctic current at 32°, the cold must finally penetrate to very great depths. Then, should the polar current by any means be shut off, and a warm current flow over it, the temperature would certainly be raised several degrees, and produce an expansion which would find relief in raising mountain ridges, or in arching up its own or other regions. This might go on slowly till great areas were elevated from the ocean.

Rising from the sea, also, would increase the temperature very much, to heave up mountains and plateaus, or still other lands from the sea. This result it seems would have to occur, because of the great depths to which the expansion would reach, and because there would exist no provision for relief of the tension, such as the repeated yearly expansion would work out for itself.

It seems these results must flow from what we already know, whether there is or not, any other cause of elevation. There are some further considerations that may be noticed here.

Where a deep ocean trough bearing an arctic current lies along beside a continent it would form a fixed barrier to such expansions, and probably a chain of mountains would be forced up along it, together with volcanos and earthquakes. The region of least yearly change and greatest cold is said to be in the northern edges of America and Siberia, and the bar connecting them across the pole. From the ends of this region the annual change increases southward and laterally. Singularly, the principal mountain systems of the northern hemisphere seem as if raised by forces or thrusts radiating from this bar and its ends. In America, as Dana shows, the original core of the continent was V-shaped, with its two ridges facing the end of that cold bar between them. And the later elevations preserve parallelism to these original lines, as if showing thrusts from that bar and from each other. In Europasia occur continuations of the same parallelism of elevations as facing thrusts radiating from the sides and the other and broader end of the same cold bar, to the areas of greatest annual changes southward, with still increased force and complexity.

In the southern hemisphere the bases of thrust seem as if, on the contrary, they were the three great ocean beds. And the great mountain systems of the world seem as if raised by thrusts of force radiating from these great northern and southern centers of land and ocean, opposing each other, together with some cross thrusts over broad areas of land. This feature of opposition between the northern land thrusts and the southern ocean beds, brings some of the principal lines of elevation in the northern hemisphere into diagonal courses, except where sweeping around the northern projections of the oceans, especially that of the Indian ocean, and its former connection west to the Atlantic south of Europe.

The present Alleghany system seems to have been raised by the elevation of the Mississippi Valley from the sea during and after the Carboniferous period; the Rocky Mountains by that of the plains, later; and the Alps by that of Northern Africa and Northern Europe, although previous elevations existed.

The familiar example of ice creeping up the shores of ponds and lakes, from repeated changes of temperature in winter, illustrates the principle of such elevations, the walled lakes of Iowa being special illustrations; and interesting observations have been published, showing from fixed levels that oscillations of level do occur from changes of temperature.

REMARKS ON A PATHOGENIC SCHIZOPHYTE.*

Prof. H. J. Detmers.

When about two and a half years ago it became my duty to investigate the prevailing Swine-plague, the so-called Hog-cholera, I first endeavored to ascertain the nature and the cause of that disease, and to accomplish my object, made numerous post-mortem examinations, and paid special attention to the microscopic examinations of the blood and of the morbid products and morbid tissues. Although the microscope at my disposal at the beginning of my investigation is only a small No. VIII Hartnack stand with three Hartnack and Prazmowski objectives—a 1 inch, a ¼ inch, and a 1-9th inch imm. and correctives—and consequently not a strictly first-class instrument, and in its performance by no means equal to the work of a Tolles or a Zeiss, I soon became convinced that the blood, the morbid products, and the morbid tissues of the diseased and dead animal invariably contained, while fresh, and not tainted by putrefaction, a certain kind of Schizophytes or bacteria. The same presented themselves in three different shapes, namely as small globular bacteria or Micrococci, as Zoöglœa-masses or clusters, imbedded in, or kept together by, a viscous mass, and as little rods or filaments. I soon found that all three forms belong to the same organism, and represent only different stages of development. The first or globular form predominated in the blood, the second in the morbid tissues—for instance, in the diseased portions of the lungs and in the lymphatic

* Read before the State Microscopical Society, of Illinois, April 8th, 1881.

glands—and the rods occurred in greatest numbers in such morbidly changed parts and morbid products—for instance, in the ulcerous tumors of the intestines—as are accessible to atmospheric air and other external influences.

The constant occurrence of these Schizophytes soon made it appear probable that their presence is not merely accidental, but that the same, very likely, are connected with, and characteristic of, the morbid process of the disease. To get at the facts was one of my principal endeavors. How far I have succeeded I leave to others to judge.

Careful and repeated macroscopic and microscopic examinations of the tissues, but especially of the lungs, which, by the way, are always more or less affected by the morbid process of Swine-plague, soon revealed the fact that the principal morbid changes are brought about in the following way: The finer capillary blood vessels become obstructed or plugged, the more fluid portions of the blood exude into the tissues—in the lungs principally and at first into the lobules, and then into the interlobular connective tissue—some, and particularly in young animals not seldom but a great many, of the finest capillaries rupture, and innumerable small extravasations of blood, visible to the naked eye as tiny red spots, are deposited into the tissue. In the skin, subcutaneous tissue, and intestinal membranes the process is essentially the same, but to follow it further would lead too far for the present. Let me, therefore, mention another fact. While the blood taken from a vein of a diseased or dead pig invariably contains a large number of spherical bacteria or Micrococci, and very few, and usually small Zoöglœa-masses, the diseased parts of the lungs, and especially the stagnant blood, which oozes out of the capillaries, if the diseased parts of the lungs are cut into small pieces, invariably contains, besides Micrococci, numerous and large Zoöglœa-masses, which are, most of them, much larger than the blood corpuscles, and abundantly large enough to clog the finer capillaries. All this, of course, does not prove that the Schizophytes constitute the cause of the morbid process. I therefore resorted to experiments. Having found that any inoculation of a healthy pig with the fresh pulmonary exudations of a diseased or dead animal invariably produces the disease in three to fifteen days, or on an average in six days, I concluded it might be ascertained in two different ways—in a negative and in a positive way—whether or not the Schizophytes constitute the cause of the morbid process. If it were possible to free the Schizophytes from everything, and to transfer the same without any vehicle whatever from one animal to another, for instance, like a louse or an itch-mite, the question would be very soon answered. But as that cannot be done, I had to get at the facts in a more indirect way. I repeatedly charged two ounces of an innocent fluid, at first pure and fresh milk, then boiled milk, mutton broth, afterwards water, and finally albumen, with one drop of the infectious pulmonary exudation, containing an abundance of Schizophytes. In about three days the fluids thus charged, which, by the way, were kept at a suitable temperature, were found to be swarming with Schizophytes, identical in appearance to those found in the pulmonary exudation; and every inoculation made with these fluids proved to be effective, but in most cases the attack produced was of a comparatively mild type. To go further into particulars would take too much time; I therefore have to refer for particulars to my reports to the Commissioners of Agriculture. One thing, however, I must state. The fluid transferred by each inoculation was less than half a drop, but this half drop contained innumerable Schizophytes, while as far as could be ascertained by careful microscopic examinations, nothing else contained in the original exudation had multiplied. Consequently, nobody, unless he believes in the power of Hahnemannian dilutions, will contradict, and say, the effect of the inoculations is brought about, not by the Schizophytes, but by an unseen and unknown virus, or chemical something, the existence of which cannot be proved. I was, however, not satisfied with these positive results, and concluded to try also the negative way. Knowing that it is impossible to separate the Schizophytes from their vehicle, I tried to free the latter from the Schizophytes, and resorted to filtration. I filtrated the pulmonary exudations through half a dozen of the finest filtering papers obtainable, but found my effort to be in vain, for the filtrate, although freed from the Zoöglœa-masses and rod-shaped bacteria, yet contained numerous Micrococcus-forms. The filtrate was put in a vial with a tight fitting glass-stopper, and when examined three days later, it contained a great many rod-shaped bacteria, and comparatively few Micrococci. I therefore filtered it again with the same result, except that the Micrococcus-forms were not as numerous after the second filtration as after the first. So I filtered the exudation three or four times, each time through four to six filtering papers, and at intervals of about three days till I was finally not able to detect any Micrococci in the now limpid filtrate. Inoculations with this filtrate proved to be ineffective. At another time—in the following winter—I tried again to free pulmonary exudation from the Schizophytes by means of filtration, but did not succeed. The filtrate always — after each filtration — contained numerous Micrococci. Whether, in this second attempt, I did not hit the right time for my second and third filtrations, that is, a time at which most or all of the micrococci had developed to rod-shaped Schizophytes or filaments; whether the temperature was too low—the first, successful attempt was made in the summer—and therefore the development of the Schizophytes was irregular or retarded; whether my filtering papers were not fine enough; or whether all these circumstances combined made the filtration a failure, I do not know. An inoculation made with this filtrate proved to be effective, but the disease produced was of a very mild character; at any rate, the animal recovered.

If more proof is yet required that the Swine-plague-Schizophytes and nothing else constitute the infectious principle of that disease, and it seems that the above facts which have been published more fully in my reports to the Commissioner of Agriculture, are not deemed sufficient, the following facts, if not making it absolutely certain, will at any rate, especially if considered *in toto*, to a great extent, corroborate the assertion that the Schizophytes have, and must have, a causal connection with the morbid process.

1. It has been, and can be, everywhere observed, where Swine-plague is prevailing, that the infectious principle floating in the air, is attracted and taken up by sores, wounds and even scratches, but does not enter the animal organism through the whole skin and through perfectly healthy respiratory mucous membranes.

2. Antiseptics, or medicines, which are either directly poisonous to the lower forms of organic life, or destructive to those conditions, under which low forms of organic life thrive and develop, and among those antiseptics, especially carbolic acid, iodine, hyposulphite of soda, benzoate of soda, thymol, etc., have proved to constitute almost sure prophylactics. As one of the conditions necessary to the development of Swine-plague bacteria, it seems, has to be considered a certain degree of animal heat. At any rate, after, and while the animal heat of a pig is reduced by a continued treatment with carbolic acid, from the normal (102° to 104° F) to an abnormally low temperature (say 96° to 97° F), every innoculation with fresh infectious material has so far proved to remain ineffective. Further, the various antiseptics, which have proved to be good prophylactics, are very dissimilar in their chemical affinities and actions, and their prophylactic effect cannot very well be explained, if the infectious principle were a chemical agency, a virus, or a poison, but is explained, if the same consist in something endowed with life and power of propagation.

3. If the morbid process, the morbid changes effected, particularly the exudations and extravasations of blood on the lungs and in the skin, and the qualitatively unchanged condition of the blood—that is excepting such changes in its composition as are evidently the product, or necessary consequence, of the morbid changes—are taken into consideration, it becomes obvious that something which causes obstructions in the capillary system —embolism—must constitute the cause, and nothing whatever, able to accomplish that result, can be found, except the colonies or clusters of Schizophytes, the Zoöglœa-masses, imbedded in a viscous substance, while on the other hand, these Zoöglœa-masses are never absent in a case of Swine-plague.

If I am allowed to digress a little, it may be here mentioned that I am well aware of the fact that German and French investigators claim for certain, and it may be, for all, kinds of pathogenic Schizophytes chemical actions or fermenting properties, and undoubtedly many of them, especially among those belonging to the genus Bacillus —I mention *B. anthracis*—and probably some others, do possess and exercise such properties, and cause fermentation. As to the Swine-plague Schizophytes, I have not been able to observe any fermenting effect or chemical action, except such as necessarily results from depriving the animal organism of certain elements and material, appropriated by the Schizophytes, and necessary to their subsistence and propagation. All other morbid changes appear to be the consequence of the obstruction of the capillary system by the Zoöglœa-masses, and therefore, are the product of a mechanical, and not of a chemical agency.

4. The adversaries of the so-called "Germ-theory" of diseases, well knowing that a perfect separation of the Schizophytes (Micrococci, Bacteria, or Bacilli, as the case may be) from their vehicles, the animal tissues and fluids, is impossible, demand absolute proof. If conclusions may be drawn from analogy between diseases of animals and plants, Prof. T. J. Burrill,* of the Illinois Industrial University, more favored by the nature of the objects of his investigation (apple-trees, pear-trees and peach-trees) has furnished evidence, amounting to almost absolute proof, that the so-called blight of apple-trees and pear-trees, and the so-called "yellows" of peaches are caused by Schizophytes similar in size, but otherwise not identical to those which I consider as constituting the cause and infectious principle of Swine-plague, as will be seen by consulting the transactions of the meeting of the American Association for the Advancement of Science in Boston, 1880.

If the infectious principle were a chemical poison or virus, its action, one should suppose, would under all circumstances be exactly the same, and the malignancy of the morbid process, and the time required for its development—the so-called period of incubation, or, more correctly, stage of colonization—would not be subject to changes dependent upon the season of the year, upon the individuality and temperature of the animal, and upon other yet unknown external influences, as is undoubtedly the case. An organic poison or virus, one should suppose, would act somewhat like the virus of a poisonous snake. In the same localities, in the same places, or the same yards and pens, and among the same breeds of hogs, in which the disease was exceedingly malignant in 1878; it was, as a rule, much milder in 1879, and still milder in 1880. As such are unmistakable facts, repeatedly and everywhere observed, it must be concluded that nothing but what is able to undergo changes is subject to growth and development, and acquires vigor and propagates rapidly under favorable, but is weakened and multiplies slowly under unfavorable circumstances—in other words, nothing but what is corporeal and endowed with life—can constitute the cause.

* "SCIENCE," Vol. I., pp. 162, 191.

6. If the cause and infectious principle of Swine-plague were a chemical poison or virus, one should suppose a cessation of the morbid process would be impossible, and an animal would never recover, while its organism contains an abundance of the infectious principle in an effective condition, as is undoubtedly the case, because convalescents, and animals nearly recovered, frequently communicate the disease, even in a fatal form, to other, healthy pigs. Further, the fact that an animal, once recovered, possesses but little predisposition for future infection, or is seldom attacked a second time, even if ever so much exposed, and then only contracts the disease in a comparatively mild form, could never be explained; but the whole presents an entirely different aspect, and admits explanation, if low and minute forms of organic life, such as the Schizophytes of Swine-plague, which, by developing and multiplying, finally destroy or exhaust in an animal organism the conditions necessary to future development and propagation, constitute the cause and the infectious principle. (cf. an article entitled: "*The Destruction of Germs*," in "*Popular Science Monthly*," communicated in extract in *R. Hitchcock's Microscopical Journal*, Nov., 1880.)

7. If some part or organ of a pig infected with Swine-plague happens to be in a state of congestion, such a part invariably attracts the infectious principle, and becomes a prominent, if not the principal, seat of the morbid process; a fact difficult of explanation, unless the infectious principal is something solid or corporeal.

8. The adversaries of the so-called "Germ Theory," as they are pleased to call it, demand absolute proof of those who claim that certain infectious diseases owe their origin, or existence and spreading, to very minute forms of organic life. They cannot deny that these forms exist, can be found, and have been shown, but forget to show their virus, poison, fluidum, or chemical something. Does the latter exist only in their imagination? If the adversaries of the so-called "Germ Theory" demand absolute proof on our side of the question, let them set a good example and furnish it on their side, or only produce their virus, fluidum, or whatever it may be, and we will gracefully acknowledge that we are mistaken, and have labored in vain.

9. With the very best objectives ever made, and a fair ability to handle the microscope, I have never been able to find anything identical to the Swine-plague Schizophytes in the blood and tissues of other healthy animals. When I commenced my investigation, the best objective at my disposal was a very fair 1–9 four system immersion lens of Hartnack & Prazmowski, but I soon found it to be insufficient, and procured a 1–16 immersion of the same makers. This, too, after a while, did not give satisfaction, and I received a 1–12 (nominally 1–10) glycerine immersion of R. B. Tolles, which that renowned maker afterwards exchanged for a duplex 1–10 homogeneous immersion. This latter objective proved to be a very superior lens, and gave me glimpses of things of which I desired to see a little more—it showed flagella on *Bacillus subtiles*, which I had never seen with any of the other objectives—and so I thought with a higher power, and a still more perfectly corrected lens, if a more perfect correction could be made, I might be able to see more plainly the distinguishing forms and characteristics of the Swine-plague Schizophytes, and also learn a little more about their mode and manner of propagation. I therefore asked Mr. Tolles to make me a higher power objective especially adapted to my work, and he has furnished me a duplex 1–15 homogeneous immersion objective (in reality a little more than a 1–16), which is, beyond comparison, the best objective I have ever seen. It is even superior, in definition and flatness of field, to a magnificent 1–18 homogeneous immersion objective (in reality a 1–20) of Carl Zeiss, made to order a month or two ago.

As to a proper generic place and name of these Swine-plague Schizophytes, I am at a loss. The best authorities—

Cohn, Klebs, and others—who have attempted a classification are somewhat undecided themselves, and do not agree where generic lines ought to be drawn. At any rate, the Swine-plague Schizophytes do not fit into any of the genera proposed. They are not bacteria, because the single cells are spherical and not oblong; they can hardly be considered as Micrococci, because the same are bi-spherical in their advanced stage of development; and they cannot be classed among the Bacilli on account of their forming Zoöglœa-masses. I have, therefore, preferred to use, for the present, that name, which, without any serious contradiction, is given by modern investigators to the whole family: Schizophytæ or Schizophytes, or the older name, introduced by Naegeli, Schizomycetes.

The Swine-plague Schizophytes present themselves, according to their stage of development, in three different forms and shapes. Their simplest form, it seems, is that of a Micrococcus, or of a small globule of about 0. 7 or 0. 8 microm. ($\frac{1}{3500}$ inch) in diameter. It occurs invariably in the blood, the morbid products, and exudations, etc. of the diseased animals, and is never absent, but can always be found, though in some cases in much greater numbers than in others. The second form is bi-spherical – the spherical cell having duplicated itself by a gradual contraction in the middle, while growing endwise. These bi-spherical Schizophytes are always more or less numerous, and are motile, or move about, provided the temperature of their vehicle—lung-exudation or blood-serum, for instance—is not too low. Some of them, but probably only those, which, separated from a larger chain, as will presently be explained, are provided, at any rate at one end, with a flagellum—a post-flagellum—which, however, is so exceedingly fine that it can be seen only with the very best high-power objectives, like a Tolles 1–15, and the most favorable light obtainable, and even then only while the Schizophyte is slowly moving. I have never yet been able to see it while the Schizophyte is at rest.

These double Micrococci, or bi-spherical Schizophytes, soon undergo further development. Each single cell soon again contracts in the middle while growing endwise, and, at the same time, separates more and more, and becomes partially independent from its sister cell, with which, however, it remains connected for some time, even after it has completed its duplication. Meanwhile the sister-cell, too, has become bi-spherical, and what a short while ago was a simple bi-spherical cell, has become a double bi-spherical body, resembling a small chain of four round joints. But the duplication does not stop; each of the four single cells, within a short time, doubles again, and soon quite a little rod or filament will be formed, which, on close inspection, presents a string or chain of bi-spherical cells endways, loosely connected with each other. Under moderately high powers—say of 800 or 900 diameters—such a string presents a slender, rod-shaped moniliform bacterium. While the single cells, or each half of each bi-spherical body, soon develop into double or bi-spherical cells, the connection between the latter gradually loosens, so that finally, if the temperature is not too low, and the development a rapid one—I have frequently observed that the number of bi-spherical cells in such a chain becomes doubled in less than five minutes—the chain breaks up into smaller ones (joints), each consisting of one or two bi-spherical Schizophytes, which, in separating from their neighbors, after some swinging to and fro, spin or draw out a very slender thread, a flagellum or cilium. But before all these changes, this rapid duplication, take place, the spherical Micrococci, when about to change to bi-spherical bodies, form those clusters (Zoöglœa or Coccoglia masses), which, being imbedded in, or kept together by, an apparently viscous substance, obstruct the capillaries, and, according to my observations, constitute the principal and direct cause of the morbid process. In these Zoöglœa-masses the single Micrococci, it seems, undergo their first metamorphosis, or change to double bi-spherical cells, and this change continues, till portions of the Zoöglœa-mass separate, or till finally the glia breaks and opens, when the bi-spherical bodies, and also some yet unchanged spherical Micrococci, become free. The former, very soon, commence their duplication, but as each new cell or globule soon produces another one and becomes bi-spherical, the same cannot be the source of the spheriral bodies or Micrococci. The latter, it appears, have another origin, as will be presently explained.

In Swine-plague material, such as blood, blood-serum, lung-exudation, etc., if a day or two old, and sometimes while yet fresh, bacteria of a peculiar shape and form make their appearance. The same are rod-shaped, and a trifle longer than a bi-spherical Schizophyte, or two united spherical bodies, but are not moniliform, and have at one end, or in comparatively rare cases toward the middle, a bright and light-refracting globule of much more density than the rest of the bacterium. This globule is surrounded by a substance or an envelope of considerably less density and is therefore less light-refracting. If that globule is situated at one end of the bacterium as is usually the case, the whole bacterium presents the shape of a club, because the globule and its envelope have much more diameter than the rod. Billroth calls this form a Helobacterium, and the globule a lasting spore (Dauerspore). Such a lasting spore, according to Billroth and Cohn, at any rate, if developed by a Bacillus, is able to resist very high degrees of heat and cold, and is very prolific, as it disseminates a large number of germs, which, probably, constitute the source of the globular bacteria or Micrcocci. As such Helobacteria are often found in perfectly fresh blood, and exudations, etc. (in the exudations most frequently) of hogs, which are affected with, or have died of Swine-plague, and are nearly always seen if the blood and exudations, etc., are a few days old, it appears probable that the same not only constitute the source of the spherical bacteria or Micrococci, but also that their great tenacity of life, or resistibility against adverse external influences, explains the ability of the infectious principle of Swine-plague to remain effective for a whole year, if protected, by clinging to, or being imbedded, in a moist and porous substance, such as an old straw stack, etc.

Whether or not Swine-plague-Schizophytes are able to multiply in any other form and manner than stated, I have not been able to observe. One observation, made already at the beginning, has found new and repeated confirmation, viz: wherever, or as soon as *Bacterium termo* makes its appearance in large numbers, the Swine-plague Schizophytes commence to disappear and disappear in about the same ratio, in which the former are increasing in numbers. In blood kept in a vial, Swine-plague Schizophytes cannot be found when the blood commences to exhibit a purplish color, or when the blood corpuscles commence to decay, or become destroyed. Further, the Swine-plague Schizophytes, although presenting the same general characteristics when cultivated in fluids foreign to the animal organism of a hog, show differences in so far as the same present less uniformity in size, and as this development and multiplication proceed slower, and with much less regularity. It seems the cultivated Schizophytes change and develop slower, and probably on that account are less vigorous in producing mischief—at any rate, an inoculation with cultivated Swine-plague Schizophytes, although effective in producing the disease, is always followed by a comparatively milder form of Swine-plague than an inoculation with material directly from the body of a diseased hog. This, however, does not involve that every inoculation with cultivated Schizophytes produces under all circumstances a milder form of Swine-plague, than any natural infection, for such is not the case. The difference may be stated thus: A natural infection, or an inoculation with material directly from the body of a diseased hog, as a rule, produces a malignant and dangerous attack

and as an exception a mild form of the disease—the frequency of the exception depending, it seems, to a great extent upon the prevailing character of the plague, while an inoculation with the cultivated Schizophytes is, as a rule, followed by a mild attack, and as an exception, or in rare cases only, by Swine-plague in its severest form.

Wherever Swine-plague is prevailing in its most malignant or fatal form, or, what is essentially the same, wherever formation of ulcerous tumors in the cæcum and colon is a frequent occurrence, where consequently an abundance of Swine-plague Schizophytes is discharged with the excrements of the diseased animals, there the spreading from animal to animal, and from herd to herd, is a rapid one; and *vice versa*, wherever the spreading is rapid, there ulcerous tumors in the intestines are a frequent occurrence. In 1878 the same (the ulcerous tumors) could be found in about 75 per cent. of all cases that had a fatal termination, while at present (in Illinois) their occurrence is probably limited to about 5 per cent. of all cases.

THE KANSAS CITY ELECTRIC TIME BALL.

By Prof. H. S. PRITCHETT, Astronomer at Morrison Observatory, Glasgow, Missouri.

The first time ball established in the United States was dropped from the dome of the Naval Observatory at Washington in 1855, It is still dropped at Washington mean noon, and has for a long time furnished the standard time for the city and the Departments of the Government.

The New York time ball, established in 1877, is dropped at New York noon, by an electric signal, sent from the Naval Observatory at Washington. It was erected and is maintained by the Western Union Telegraph Company, and is dropped from their building on Broadway. At 11h. 55m. the ball is hoisted half-way up the staff on the tower of the building. At 11h. 58m. it is hoisted to its highest point, when it is about 250 feet above the street and can be well seen by the shipping at the New York and Brooklyn docks, and vessels in the bay, and from suitable positions is visible to a large part of the citizens of New York, Brooklyn, Hoboken and Jersey City.

If on account of wind the ball fails to drop at 12h. om. os., it is held till 12h. 5m. and then dropped. In such cases a small red flag is hoisted at 12h. 1m. and kept flying till 12h. 10m. This ball was for some time dropped by hand, but for the last year the dropping has been automatically effected by the clock at the Observatory. The working of the apparatus has been in the main satisfactory, and the ball has been dropped quite regularly, the failures being caused almost entirely by temporary breaks in the wire or other causes which could not be foreseen.

In the evening papers of the day and in the papers of the next morning a notice is regularly inserted, stating whether the ball dropped at correct time, and if not, its error, fast or slow. Many are at a loss to know how this correction is obtained. It is arrived at in the following manner: The time of the falling of the ball records itself automatically by electricity, near the standard clock of the Western Union Company in the building, the clock itself being regulated by the daily clock-signals from Washington. The difference between the time of falling of the ball and noon, as indicated by the clock, is thus obtained by a direct comparison. This assumes of course the accuracy of the clock, and during a long continued season of cloudy weather, or in case of accident to the clock itself, the time might be somewhat in error, although the published correction might show but a few hundreths of a second. At present however, the Western Union has the benefit also of the Alleghany and Cambridge signals, for the regulation of this clock, so that even during the longest season of cloudy weather it is not probable that the clock could be much in error.

The Boston time ball, which is dropped at noon of Boston time, by means of the noon-time signal from the standard clock of the Harvard College Observatory, is placed upon the large building of the Equitable Life Assurance Company and was paid for and is now maintained by this company. The ball is of copper and weighs about 250 pounds. The machinery used in raising and controlling it is hence much more complicated and costly than in either of the cases before mentioned. The cost of ball and machinery was about $1200. The electric signal which drops it, is given by the clock itself, the ball having a drop of fifteen feet. The nearness of the Observatory, and the fact that the wire used is wholly under its control, give additional convenience and certainty in the dropping of the ball, and reduces the probability of accidents to a minimum, so that it is effected with great regularity and precision. Prof. Pickering, Director of the Observatory, reports for the year ending Nov. 1st, 1880, the ball was dropped exactly at noon on 355 days; on four other days at five minutes past noon, in accordance with the rule adopted; on four other days it was not dropped, leaving only three cases of inaccuracy of dropping.

Quite recently a time ball has been established at Hartford, Conn., and dropped by the Winchester Observatory of Yale College.

The time ball recently erected at Kansas City, and which is dropped as a part of the time service of the Morrison Observatory, is the first attempt in this direction in the West. It was paid for chiefly by an appropriation of the City Council of that city. The site selected was the large building just erected by the Messrs. Bullene, Moores & Emery, on Delaware street. The ball when raised to the top of the staff is about 140 feet above the street, and is generally visible to the business portion of the city. The ball which passes over the staff, is simply a wire skeleton covered with canvas and painted black, and is about three feet in diameter. It was loaded on the inside with lead until it was found to drop instantly and without loss of time. It has a drop of about twenty-five feet and is slowed up as it reaches the bottom, and is received upon a set of tall springs surmounted by a stout cushion.

The apparatus by means of which the ball is dropped at precisely the right instant, was constructed under the direction of Mr. W. F. Gardner, the instrument maker of the Naval Observatory at Washington, It is of a very simple form, and is found to answer all requirements.

This has been found to work easily and without loss of time and can scarcely get out of order. The entire cost of mounting the ball and machinery was only about $120, and with this small amount it was necessary to use the utmost economy in the purchase of materials and apparatus. Kansas City is about one hundred miles from the Observatory, and except in cases of breaking of the wire, when the ball cannot be dropped at all, it is dropped within one or two-tenths of a second of correct time.

The discrepancy in the local time kept by different jewelers in the city before the erection of the ball was astonishing, and led to endless confusion in business and travel.

On the first day the ball dropped, this difference, in extreme cases, amounted to fifteen or twenty minutes, some being eight or ten minutes fast, others as slow. The establishment of the time ball has brought about a uniformity never before known, and must soon make itself felt, not only as a convenience, but a promoter of punctuality in business engagements.

From the daily clock-signals sent over the wires from the Observatory it will be easy to establish a similar time signal in any city in the West, which will take the

necessary steps to procure these signals. An arrangement has been made also by which they may be distributed to jewelers and clockmakers, and manufacturing establishments in the larger cities.

THE UNITY OF NATURE.

By the Duke of Argyll.

VII.

ON THE MORAL CHARACTER OF MAN CONSIDERED IN THE LIGHT OF THE UNITY OF NATURE.

(*Continued*).

Of one thing, at least, we may be tolerably certain respecting the causes which have led to this extreme dispersion of Mankind to inhospitable regions, at a vast distance from any possible center of their birth. The first Fuegian was not impelled to Cape Horn by the same motives which impelled Mr. Darwin to visit that country in the *Beagle*. The first Eskimo, who wintered on the shores of Baffin's Bay, was not induced to do so for the same reasons which led to the expeditions of Back, of Franklin, or of Rae. The first inhabitants of Australasia did not voyage there under conditions similar to those which attended the voyages of Tasman or of Cook. We cannot suppose that those distant shores were first colonized by men possessed with the genius, and far advanced in the triumphs, of modern civilization. Still less can we suppose that they went there under the influence of that last development of Man's intellectual nature, which leads him to endure almost any suffering in the cause of purely scientific investigation.

Nor is this the only solution of the difficulty which seems to be absolutely excluded by the circumstances of the case. Within the historical period, and in the dim centuries which lie immediately beyond it, we know that many lands have been occupied by conquering races coming from a distance. Sometimes they came to subdue tribes which had long preceded them in occupation, but which were ruder, as well as weaker, than themselves. Sometimes, as in the case of the northern nations bursting in upon the Roman empire, they came to overthrow a civilization which had once been, and in many ways still was, much higher than their own, but which the progress of development in a wrong direction had sunk in degradation and decay. Sometimes they came simply to colonize new lands, at least as favored, and generally much more favored, than their own—bringing with them all the resources of which they were possessed—their flocks and herds, their women and children, as well as their warriors with chariots and horses. Such was the case with some of those nations which at various times have held their sway from Central Asia into Eastern and Central Europe. They were nations on the march. But no movement of a like kind has taken place for many centuries. Lastly, we have the emigrations of our own day, when civilized men, carrying with them all the knowledge, all the requirements, and all the materials of an advanced civilization, have landed in countries which by means of these could be made fit for settlement, and could be converted into the seats of agriculture and of commerce.

Not one of these cases can reasonably be supposed to have been the case of the first arrival of Man in Australasia. The natural disadvantages of the country, as compared with the richness and abundance of the regions from which he must have come, or which were on his southward line of march, preclude the supposition that men were attracted to it by natural objects of desire. We know by experience that if the first settlers had been in a condition to bring with them the higher animals which abound in Asia, these animals would have flourished in Australia as they now do. And so, also, with reference to the cereals—if these had ever been introduced, the modern Australians would not have been wholly without them, and would not have been compelled to live so much on the lowest kinds of animal and vegetable food—on fish, lizards, grubs, snakes, and the roots of ferns.

There is, however, one answer to Mr. Darwin's question, which satisfies all the conditions of the case. There is one explanation, and only one, of the dispersion of the human race to the uttermost extremities of the habitable globe. The secret lies in that great law which Malthus was the first to observe and to establish—the law, namely, that population is always pressing on the limits of subsistence. There is a constant tendency to multiplication beyond those limits. And, among the many consequences of this tendency, the necessity of dispersion stands first and foremost. It is true, indeed, that under some conditions, such as those which have been already indicated, the most energetic races, or the most energetic individuals, have been those who moved. But under many other conditions the advantage has been in favor of those who staid. Quarrels and wars between tribe and tribe, induced by the mere increase of numbers, and by consequent pressure upon the means of living, have been always, ever since Man existed, driving the weaker individuals and the weaker families farther and farther from the original settlements of Mankind.

Then one great argument remains. In the nature of things the original settlements of Man must of necessity have been the most highly favored in the conditions he requires. If, on the commonly received theory of Development, those conditions produced him, they must have reached at the time when, and in the place where, he arose, the very highest degree of perfect adaptation. He must have been happy in the circumstances in which he found himself placed, and presumably he must have been contented to remain there. Equally on the theory of Man being a special creation, we must suppose that when weakest and most ignorant he must have been placed in what was to him a garden—that is to say, in some region where the fruits of the earth were abundant and easily accessible. Whether this region were wide or narrow, he would not naturally leave it except from necessity. On every possible supposition, therefore, as to the origin of Man, those who in the dispersion of the race were first subjected to hard and unfavorable conditions would naturally be those who had least strength to meet them, and upon whom they would have accordingly the most depressing effect. This is a process of Natural Rejection which is the inseparable correlative of the process of Natural Selection. It tends to development in a wrong direction by the combined action of two different circumstances which are inherent in the nature of the case. First, it must be always the weaker men who are driven out from comfortable homes; and, secondly, it must be always to comparativly unfavorable regions that they are compelled to fly. Under the operation of causes so combined as these, it would be strange, indeed, if the physical and mental condition of the tribes which have been exposed to them should remain unchanged. It is true, indeed, that adverse conditions, if they be not too severe, may develop energy, and result in the establishment of races of special hardihood. And in many cases this has been the actual result. But, on the other hand, if physical conditions be as insuperable as those which prevail in Tierra del Fuego or in Baffin's Bay; or if, though less severe than these, they are nevertheless too hard to be overcome by the resources at the disposal of the men who are driven to encounter them, then the battle of life becomes a losing one. Under such circumstances, degration is unavoidable. As surely as the progress of Man is the result of opportunity, that is to say, as surely as it is due to the working of his faculties under stimulating and favoring conditions, so surely must he descend in the scale of intelligence and culture, when that opportunity is taken from him, and when these faculties are placed under conditions where they have no call to work.

It is, then, easy to see some at least of the external circumstances, which, first, in the natural course of things,

would bring an adverse influence to bear upon Mankind. Here we are on firm ground, because we know the law from which comes the necessity of migrations, and the force which has propelled successive generations of men farther and farther in ever widening circles round the original centre or centres of their birth. Then, as it would be always the feebler tribes which would be driven from the ground which has become overstocked, and as the lands to which they went forth were less and less hospitable in climate and productions, the struggle for life would be alwaye harder. And so it would generally happen, in the natural course of things, that the races which were driven farthest would become the rudest and the most engrossed in the pursuits of mere animal existence.

Accordingly, we find that this key of principle fits into and explains many of those facts in the distribution and condition of Mankind, which, in the case of the Fuegians, excited the wonder and curiosity of Darwin. In the light of this explanation, these facts seem to take form and order. It is a fact that the lowest and rudest tribes in the population of the globe have been found, as we have seen, at the farthest extremities of its larger continents—or in the distant islands of its great oceans, or among the hills and forests which in every land have been the last refuge of the victims of violence and misfortune. These extreme points of land which in both hemispheres extend into severe latitudes are not the only portions of the globe which are highly unfavorable to man. There are other regions quite as bad, if not, in some respects, even worse. In the dense, uniform and gloomy forests of the Amazon and Orinoco there are tribes which seem to be among the lowest in the world. It cannot be unconnected with the savagery of the condition to which they have been reduced that we find the remarkable fact that all those regions of Tropical America are wholly wanting in the animals which are capable of domestication; and which are inseparable from the earliest traces of human culture. The Ox, the Horse, and the Sheep are all absent—even as regards the genera to which they belong. There are indeed the Tapir, the Paca, and the Curassow Turkey, and all these are animals which can be tamed. But none of them will breed in confinement, and the races cannot be established as useful servants of Mankind. In contrast with these and with other insuperable disadvantages of men driven into the forests of Tropical America, it is instructive to observe that the same races, where free from these disadvantages, were never reduced to the same condition. In Peru the Indian races had the Llama, and had also an advanced civilization.[4] In India, too, it is always the Hill Tribes who furnish the least favorable specimens of our race. But in every one of these cases we have the presence of external circumstances and physical conditions which are comparatively unfavorable. It is quite certain that these conditions must have had their own effect. It is equally certain that the races which have been subject to them for a long and indefinite time must have been once under the influence of conditions much more favorable; and the inevitable conclusion follows, that the savagery and degradation of their existing state is to a great extent the result of development in a wrong direction.

There are other arguments all pointing the same way, the force of which cannot be fully estimated, except by those who are familiar with some of the fundamental conceptions which seem to rise unbidden in the mind from the facts which geology has revealed touching the history of Creation. One of these facts is that each new organic Form, or each new variety of birth, seems to have been introduced with a wonderful energy of life. It is needless to repeat that this fact stands in close connection with every possible theory of Evolution. If these new Forms were the product of favoring conditions, the prevalence of these conditions would start them with force upon their way. The initial energy would be great. Where every condition was favorable—so favorable indeed that the new birth is assumed to have been nothing but their natural result—then the newly-born would be strong and lusty. And such, accordingly, is the fact in that record of creation which Palæontology affords. The vigor which prevails in the youth of an individual is but the type of the vigor which has always prevailed in new and rising species. All the complex influences which led to their being born, led also to their being fat and flourishing. That which caused them to arise at all must have had the effect of causing them to prevail. The condition of all the lowest races of men is in absolute contrast with everything which this law demands. Everywhere, and in everything, they exhibit all the characteristics of an energy which is spent—of a force which has declined—of a vitality which has been arrested. In numbers they are stationary, or dwindling; in mind they are feeble and uninventive; in habits they are stupid or positively suicidal.

It is another symptom of a wrong development being the real secret of their condition that the lowest of them seem to have lost even the power to rise.. Though individually capable of learning what civilized men have taught them, yet as races they have been invariably scorched by the light of civilization, and have withered before it like a plant whose roots have failed. The power of assimilation seems to have departed, as it always does depart, from an organism which is worn out. This has not been the result with races which, though very barbarous, have never sunk below the pastoral or the agricultural stage. It is remarkable that the Indian races of North America are perhaps the highest which have exhibited this fatal and irredeemable incapacity to rise; and it is precisely in their case that we have the most direct evidence of degradation by development in a wrong direction. There are abundant remains of a very ancient American civilization, which was marked by the construction of great public works and by the development of an indigenous agriculture founded on the maize, which is a cereal indigenous to the continent of America. This civilization was subsequently destroyed or lost, and then succeeded a period in which Man relapsed into partial barbarism. The spots which had been first forest, then, perhaps, sacred monuments, and thirdly, cultivated ground, relapsed into forest once more.[5] So strong is this evidence of degradation having affected the population of a great part of the American continent, that the distinguished author from whom these words are quoted, and who generally represents the savage as the nearest living representative of primeval man, is obliged to ask, "What fatal cause destroyed this earlier civilization? Why were these fortifications forsaken—these cities in ruins? How were the populous nations which once inhabited the rich American valleys reduced to the poor tribes of savages whom the European found there? Did the North and South once before rise up in arms against one another? Did the terrible appellation, the 'Dark and Bloody Land,' applied to Kentucky, commemorate these ancient wars?"[6] Whatever may have been the original cause, the process of degradation has been going on within the historic period. When Europeans first came in contact with the Indian tribes, there was more agriculture among them then than there is now. They have long descended to the condition of pure hunters. The most fundamental of all the elements of a civilized and settled life—the love and practice of agriculture—has been lost. Development in the wrong direction had done its work. There is no insoluble mystery in this result. It is, in all probability, if indeed it be not certainly,

[4] "Naturalist on the Amazons," Bates, vol. i. p. 191–3.

[5] Lubbock, "Prehistoric Times," p. 234.

[6] *Ibid.*, p. 236.

attributable to one cause, that of internecine and devastating wars. And these again are the result of a natural and universal instinct which has its own legitimate fields of operation, but which like all other human instincts is liable to degenerate into a destructive passion. The love of dominion is strong in all men, and it has ever been strongest in the strongest races. But the love of fighting and of conquest very often does sink into a mere lust of blood. The natural rivalry of different communities may become such implacable hatred as to be satisfied with nothing short of the extermination of an enemy. Inspired by this passion, particular races or tribes have sometimes acquired a power and a ferocity in fighting, against which other tribes of a much higher character and of a much more advanced civilization have been unable to contend.

This is no fancy picture. It is a mistake to suppose that the decline of civilization in the American continent has been due to the invasion of it by Europeans since the discovery of Columbus. Just as the older civilization of that continent was an indigenous civilization founded on the cultivation of a cereal peculiar to the American continent, so also does the decay and loss of this civilization seem to have been a purely indigenous decay. Mr. Wilson, in his very interesting work on "Prehistoric Man," gives an account of the process by which barbarism has been actually seen extending among the Red Indian tribes. When the valley of the St. Lawrence first came under the observation of Europeans, some of those tribes were found to be leading a settled life, practicing agriculture, and constituting communities in possession of all the elements of a civilization fairly begun, or probably long inherited. The destruction of these communities was affected by the savage hostility of one or two particular tribes, such as the Iroquois and the Mohawks. In these tribes the lust of blood had been developed into an absorbing passion, so that their very name became a terror and a scourge, Wholly given up to war as a pursuit, their path was red with blood, and the more peaceful and civilized branches of the same stock were driven, a scanty remnant, into forests and marshes, where their condition was necessarily reduced to that of savages, living wholly by the chase. It is a curious and instructive fact that this sequence of events was so vividly and painfully remembered among some of the Red Indian tribes that it had become embodied in a religious myth. It was said that in old times the Indians were increasing so fast that they were threatened with want, and that the Great Spirit then taught them to make war, and thus to thin one another's numbers.[7] Although this myth stands in very close connection with the universal tradition of a Golden Age, or of a Past in some measure better than the Present, it is remarkable on account of the specific cause which it assigns for deterioration and decay, a cause in respect to which we have historical evidence of its actual effect. When the great French navigator, Cartier, first explored the St. Lawrence in 1534–5, he ascended to that point of its course whence the city of Montreal now looks down upon its vast and splendid prospect of fertile lands and of rushing waters. He found it occupied by the Indian town of Hochelaga—inhabited by a comparatively civilized people, busy not only in fishing or in hunting, but also in a successful husbandry. The town was strongly fortified, and it was surrounded by cultivated ground. Within one hundred and seven years—some time between 1535 and 1642—Hochelaga had utterly disappeared, with all its population, and all its culture. It had been destroyed by wars, and its site had returned to forest or to bush. To this day when men dig the foundations of new houses in Montreal they dig up the flint implements of the Hochelagans, which, although about 350 years old, may now be reckoned by the scientific anthropologist as relics of the "Stone Age,"[8] and of an ancient universal savagery. The same course of things prevailed over the greater part of Canada. During the first half of the seventeenth century a large part of the valley of the St. Lawrence, and vast tracts of country on both shores of the great Lakes, are known to have been devastated by exterminating wars. In 1626 a Jesuit missionary penetrated into the settlement of a tribe called the Attiwenderonks. He found them inhabiting towns and villages, and largely cultivating tobacco, maize and beans. The country inhabited by the tribe which has left its name in Lake Erie, is stated to have been greatly more extensive, and is everywhere covered with the marks of a similar stage of civilization. Within less than thirty years another missionary found the whole of these regions a silent desert. In like manner the country round Lake Huron was, at the same period of time, seen to be full of populous villages defended by walls, and surrounded by cultivated fields. But the same fate befell them.[9] They were extirpated by the Mohawks.

Here then we see in actual operation, within very recent times, a true cause—which is quite capable of producing the effects which, by some means or another, have certainly been produced—and that, too, on the largest scale—upon the American continent. It is a cause arising out of one of the universal instincts of Mankind, developed in such excess as to become a destructive mania. Many nations most highly civilized have been extremely warlike—and the ambition they have cherished of subduing other nations has been the means of extending over the world their own knowledge of the arts of government, and their own high attainments in the science of jurisprudence. But when the same passion takes possession of ruder men, and is directed by irrational antipathies between rival families and rival tribes, it may be, and has often been one of the most desolating scourges of humanity. In itself an abuse and a degradation which none of the lower animals exhibit, it tends always to the evolution of further evils, to the complete destruction of civilized communities or to the reduction of their scanty remnants to the condition and the habits of savage life.

It results from these facts and considerations, gathered over a wide field of observation and experience, that the processes of Evolution and Development as they work in Man, lead to consequences wholly different from those to which they lead in other departments of Creation. There, they tend always in one of two directions, both of which are directions predetermined and in perfect harmony with the unity of Nature. One of these directions is that of perfect success, the other of these directions is that of speedy extinction. Among the lower animals, when a new Form appears, it suits exactly its surrounding conditions; and when it ceases to do so it ceases to survive. Or if it does survive it lives by change, by giving birth to something new, and by ceasing to be identical with its former self. So far as we can actually see the past work of development among the beasts, it is a work which has always led either to rapid multiplication or to rapid extinction, There is no alternative. But in man the processes of Evolution lead in a great variety of directions—some of them tending more or less directly to the elevation of the creature, but others of them tending very speedily and very powerfully to its degradation. In some men they have led to an intellectual and moral standing, of which we can conceive it to be true that it is only a "little lower than the angels." In others they have ended in a condition of which it is too evidently true that it is a great deal lower than the condition of beasts.

We can get, however, a great deal nearer towards the understanding of this anomaly than the mere recognition of it as a fact. Hitherto we have been dealing only with

[7] "Fossil Men," Principal Dawson. p. 47. Montreal, 1880.

[8] "Fossil Men," Principal Dawson, pp. 29–42. Montreal, 1880.

[9] "Prehistoric Man," Dan. Wilson, pp. 359, 60.

one of the two great causes of change,—namely, that of unfavorable external or physical conditions. Let us now look at the other—namely, the internal nature and character of Man. We can see how it is that, when working under certain conditions, the peculiar powers of Man must lead to endless developments in a wrong direction. Foremost among these powers is the gift of Reason. I speak here of Reason not as the word is often used, to express a great variety of powers, but as applied to the logical faculty alone. In this restricted sense, the gift of Reason is nothing more than the gift of seeing the necessity or the natural consequences of things—whether these be things said or things done. It is the faculty by which, consciously or unconsciously, we go through the mental process expressed in the word "therefore." It is the faculty which confers on us a true gift of prophecy—the power of foreseeing that which "must shortly come to pass." In its practical application to conduct, and to the affairs of life, it is the gift by which we see the means which will secure for us certain ends, whether these ends be the getting of that which we desire, or the avoiding of that which we dread. But in its root, and in its essence, as well as in its application to the abstract reasoning of mathematics, it is simply the faculty by which we see one proposition as involving, or as following from another. The power of such a faculty obviously must be, as it actually is, immeasurable and inexhaustible, because there is no limit to this kind of following. That is to say, there is no end to the number of things which are the consequence of each other. Whatever happens in the world is the result of causes, moral or material, which have gone before, and this result again becomes the cause of other consequences, moral or material, which must follow in their turn. It is a necessary result of the unity of nature, and of the continuity of things, that the links of consequence are the links of an endless chain. It is the business of Reason to see these links as they come one by one gradually into view; and it is in the nature of a reasoning creature to be drawn along by them in the line, whatever it may be, which is the line of their direction. The distance which may be traversed in following that direction even for a short time, and by a single mind, is often very great—so great that a man may be, and often is, a different Being from himself, both in opinions and in conduct, at two different epochs of his life. There are, indeed, individuals, and there are times and conditions of society, in which thought is comparatively stagnant, when it travels nowhere, or when its movements are so slow and gradual as to be imperceptible. But, on the other hand, there are times when mind is on the march. And then it travels fast and far. The journey is immense indeed, which may be accomplished by a few successive generations of men following, one after another, the links of consequence. At the end of such a journey, the children may be separated from their fathers by more than the breadth of oceans. They may have passed into new regions of thought and of opinion, of habit and of worship. If the movement has been slow, and if the time occupied has been long, it will be all the more difficult to retrace the steps by which the change has been brought about. It will appear more absolute and complete than it really is—the new regions of thought being in truth connected with the old by a well-beaten and continuous track.

But these endless processes of development arising out of the operation of the reasoning faculty, are consistent with any result—good or bad. Whether the great changes they produce have been for the better or for the worse, must depend, not on the length of the journey, but on the original direction in which it was begun. It depends on whether that direction has been right or wrong—on whether the road taken has been the logical development of a lie. The one has a train of consequences as long and as endless as the other. It is the nature of the reasoning faculty that it works from data. But these data are supplied to it from many different sources. In the processes of reasoning on which the abstract sciences depend, the fundamental data are axioms or self-evident propositions. These may, in a sense, be said to be supplied by the reasoning faculty itself, because the recognition of a truth as self-evident is in itself an exercise of the reasoning faculty. But in all branches of knowledge, other than the abstract sciences, that is to say, in every department of thought which most nearly concerns our conduct and our beliefs, the data on which Reason has to work are supplied to it from sources external to itself. In matters of Belief, they come, for the most part, from Authority, in some one or other of its many forms, or from imagination working according to its own laws upon impressions received from the external world. In matters of conduct, the data supplied to Reason come from all the innumerable motives which are founded on the desires. But in all these different provinces of thought it is the tendency and the work of Reason to follow the proposition, or the belief, or the motive, to all its consequences. Unless, therefore, the proposition is really as true as it seems to be; unless the belief is really according to the fact; unless the motive is really legitimate and good, it is the necessary effect of the logical faculty to carry men farther and farther into the paths of error, until it lands them in depths of degradation and corruption of which unreasoning creatures are incapable. It is astonishing how reasonable—that is to say, how logical—are even the most revolting practices connected, for example, with religious worship or religious customs, provided we accept as true some fundamental conception of which they are the natural result. If it be true that the God we worship is a Being who delights in suffering, and takes pleasure, as it were, in the very smell of blood, then it is not irrational to appease Him with hecatombs of human victims. This is an extreme case. There are, however, such cases, as we know, actually existing in the world. But, short of this, the same principle is illustrated in innumerable cases, where cruel and apparently irrational customs are in reality nothing but the logical consequences of some fundamental belief respecting the nature, the character, and the commands of God. In like manner, in the region of morals and of conduct not directly connected with religious beliefs, Reason may be nothing but the servant of Desire, and in this service may have no other work to do than that of devising means to the most wicked ends. If the doctrine given to Reason be the doctrine that pleasure and self-indulgence, at whatever sacrifice to others, are the great aims and ends of life, then Reason will be busy in seeking out "many inventions" for the attainment of them, each invention being more advanced than another in its defiance of all obligation and in its abandonment of all sense of duty. Thus the development of selfishness under the guidance of faculties which place at its command the great powers of foresight and contrivance, is a kind of development quite as natural and quite as common as that which constitutes the growth of knowledge and of virtue. It is indeed a development which, under the condition supposed—that is to say, the condition of false or erroneous data supplied to the reasoning faculty—is not an accident or a contingency, but a necessary and inevitable result.

And here there is one very curious circumstance to be observed, which brings us still closer to the real seat of the anomaly which makes Man in so many ways the one great exception to the order of Nature. That circumstance is the helplessness of mere Reason to correct the kind of error which is most powerful in vitiating conduct. In those processes of abstract Reason which are the great instruments of work in the exact sciences, the reasoning faculty has the power of very soon detecting any element of error in the data from which it starts. That any given proposition leads to an absurd result is one of the familiar methods of disproof in mathematics.

That one of only two alternatives is proved to be absurd is conclusive demonstration that the other must be true. In this way Reason corrects her own operations, for the faculty which recognizes one proposition as evidently absurd, is the same faculty which recognizes another proposition as evidently true. It is, indeed, because of its contradicting something evidently true, or something which has been already proved to be true, that the absurd result is seen to be absurd. It is in this way that, in the exact sciences, erroneous data are being perpetually detected, and the sources of error are being perpetually eliminated. But reason seems to have no similar power of detecting errors in the data which are supplied to it from other departments of thought. In the developments, for example, of social habits, and of the moral sentiments on which these principally depend, no results, however extravagant or revolting, are at all certain of being rejected because of their absurdity. No practice however cruel, no custom however destructive, is sure on account of its cruelty or of of its destructiveness to be at once detected and rejected as self-evidently wrong. Reason works upon the data supplied to it by superstition, or by selfish passions and desires, apparently without any power of questioning the validity of those data, or, at all events, without any power of immediately recognizing even their most extreme results as evidently false. In Religion, at least, it would almost seem as if there were no axiomatic truths which are universally, constantly, and instinctively present to the mind—none at least, which are incapable of being obscured—and which, therefore, inevitably compel it to revolt against every course or every belief inconsistent with them. It is through this agency of erroneous belief that the very highest of our faculties, the sense of obligation, may and does become itself the most powerful of all agents in the development of evil. It consecrates what is worst in our own nature, or whatever of bad has come to be shown in the multitudinous elements which that nature contains. The consequence is, that the gift of Reason is the very gift by means of which error in belief, and vice in character, are carried from one stage of development to another, until at last they may, and they often do, result in conditions of life and conduct removed by an immeasurable distance from those which are in accordance with the order and with the analogies of Nature.

These are the conditions of life, very much lower, as we have seen, than those which prevail among the brutes, which it is now the fashion to assume to be the nearest type of the conditions from which the human race began its course. They are, in reality and on the contrary, conditions which could not possibly have been reached except after a very long journey. They are the goal at which men have arrived after running for many generations in a wrong direction. They are the result of Evolution—they are the product of Development. But it is the evolution of germs whose growth is noxious. It is the development of passions and desires, some of which are peculiar to himself, but all of which are in him freed from the guiding limitations which in every other department of Nature prevail among the motive forces of the world, and by means of which alone they work to order.

It is in the absence of these limitations that what is called the Free Will of Man consists. It is not a freedom which is absolute and unconditional. It is not a freedom which is without limitations of its own. It is not a freedom which confers on Man the power of acting except on some one or other of the motives which it is in his nature to entertain. But that nature is so infinitely complex, so many-sided, is open to so many influences, and is capable of so many movements, that practically their combinations are almost infinite. His freedom is a freedom to choose among these motives, and to choose what he knows to be the worse instead of the better part. This is the freedom without which there could be no action attaining to the rank of virtue, and this also is the freedom in the wrong exercise of which all vice consists. There is no theoretical necessity that along with this freedom there should be a propensity to use it wrongly. It is perfectly conceivable that such freedom should exist, and that all the desires and dispositions of men should be to use it rightly. Not only is this conceivable, but it is a wonder that it should be otherwise. That a Being with powers of mind and capacities of enjoyment rising high above those which belong to any other creatures, should, alone of all these creatures, have an innate tendency to use his powers, not only to his own detriment, but even to his own self-torture and destruction, is such an exception to all rule, such a departure from all order, and such a violation of all the reasonableness of Nature, that we cannot think too much of the mystery it involves. It is possible that some light may be thrown upon this mystery by following the facts connected with it into one of the principal fields of their display—namely, the History of Religion. But this must form the subject of another chapter.

ASTRONOMY.

DISCOVERY OF A NEW COMET.

Mr. Lewis Swift, of Rochester, N. Y., has announced to the Smithsonian Institution the discovery by himself, on Sunday morning, May 1st, 1881, of a bright comet in Right Ascension $0^h\ 0^m$, Declination 37° North. The comet rises a little before the sun and is moving slowly south.

Professor A. Hall makes the following enquiry in "The Analyst:" "Observations on the motions of the sun-spots have also established the fact that the sun is not strictly a fixed body, around which the earth revolves, but that it has a motion of its own thro' space."—*Physiography*, by T. H. Huxley, F. R. S., 2nd Ed., p. 365. How can the above fact be determined by observations of the sun-spots?

NOTES.

A BILL has been introduced into Parliament for the purpose of authorising the erection of a system of pneumatic clocks in the streets of London.

AUSTRALIAN TELEGRAPHY.—At the close of 1879 some 31,556 miles of telegraph wire were at work on the Australian Continent, and 40,634 miles with Tasmania and New Zealand added.

IT is said that the Telephone Company in Belgium has inaugurated a system by which subscribers leaving word the previous evening may be awakened at any hour in the morning by means of a powerful alarm.

COLONEL PARIS, the head of the Paris fire brigade, has concluded his report on the destruction of the Printemps Establishment by proposing that large warehouses be compelled to light by electricity.—*Nature*.

A FEAT IN NICKEL-PLATING.—The plating company of the Berlopton Lane Works, Stockton-on-Tees, have successfully plated with nickel three large cylinder covers for marine engines, on account of Messrs. Maudslay, Son, and Field, the eminent engineers. The largest cover weighs nearly 1¾ tons, and is 6 ft. 6 in. in diameter. It was plated in the large nickel bath, and polished all over successfully by one of Fenwick's patent portable polishing machines. The same company have also just nickel-plated the whole of the bright parts of Sir James Ramsden's yacht engines, built by the well-known firm, the Barrow Shipbuilding Company (Limited), also, some locomotive domes and safety-valve covers.

BOOKS RECEIVED.

ANIMAL LIFE AS AFFECTED BY THE NATURAL CONDITIONS OF EXISTENCE, by KARL SEMPER, Professor of the University of Würzburg. With two maps and one hundred and six wood cuts. D. Appleton & Co., New York, 1881.

Naturalists have been more than once taunted with too much philosophizing over the Darwinian theory, that they were content to form fanciful ideas as to how this or that difficulty could be hypothetically explained, and that fundamental causes—equally fanciful—were imagined to account for results which were actually observed.

We apprehend that if the Darwinian theory is to become a scientific dogma, the future course of naturalists must lie in the direction of applying the test of exact investigation to the hypotheses already laid down. The task is doubtless a laborious one, and Professor Semper himself says that to prove by experiment the truth of many of these hypotheses long and deep researches are indispensable, or the student will find himself wrecked upon insurmountable difficulties.

There are a number of eminent naturalists whose works tend in this direction, and Professor Semper now leads the van of those who would systematically apply themselves to this task.

Considering that Variability is one of the properties of the animal kingdom which might be most easily traced by exact investigation to its efficient causes, Professor Semper has made it the subject matter of his book, and to facilitate the task of himself and others, has presented a general view of those facts and hypotheses which bear upon the subject, and which are either of universal significance or appear to offer favorable subjects for experimental treatment.

It is not claimed that this work is a complete review of even this branch of the enquiry, but it lays out a plan fortified by a long array of facts, showing how the enquiry may be systematically conducted. It is thus a protest against casual and disconnected observation, and as such may be read with profit by every student.

The introductory chapters are of much interest, dealing with some of the salient points of the Darwinian theory. The plan of the work is also explained and the reader introduced to the subject.

The main body of the book is divided into two sections. The first treats of the influence of *inanimate* surroundings, and in this division Professor Semper directs attention to the influence of food, light, and temperature upon organisms. The results attributable to water, both still, and in motion, are explained, and finally other influences are considered.

In the concluding portion of this work, the influence of *living* surroundings is discussed in such a masterly manner, as to be of the highest service to those studying this subject.

We notice that the subject of the geographical distribution of animals is discussed by Professor Semper, who points out the chief difficulties in bringing into accord the various hypotheses, suggested to explain the undoubted fact that certain species overstep the limits apparently assigned to them by Nature.

Whenever any extensive resemblance between the faunas of two distinct countries is discovered or imagined, a hypothetical history of upheavals and subsidences is suggested, to form a bridge of mainland, as a mode of accounting for this resemblance. This appears to be a favorite theory of Mr. Wallace, and Professor Semper himself admits that such must have been the case in some instances, as he himself found an Indian elephant on Mindanao, the most southerly of the Philippines, for such an animal could scarcely have made the passage by sea. Nevertheless, Professor Semper considers these hypothetical connections of the islands and mainland as not sufficient by themselves to explain even those facts which are already known, as to the distribution of Indian and Australian forms on the islands lying between the two continents.

He further states that "until the question is finally settled whether two parallel series of animal development might not have proceded independently in two countries remote from each other, we can never venture to regard the resemblance of two faunas as conclusive evidence of their primæval actual connection; nay, it even seems to me that the two historical series of species of the horse, recently discovered both in Europe and America, may, on the contrary, be regarded almost as a proof that each series was developed independently on the two continents, and yet led to the same result: namely, the production of the horse."

Leaving this, however, as an open question, Professor Semper advances a theory for accounting generally for irregularities in the geographical distribution of animals, by suggesting that the action of currents and winds cooperated in a large degree in producing the results which are found to exist.

As a means of distributing animal life it is evident that winds and currents conveyed certain animals from place to place, but Professor Semper points out that these influences frequently acted as a hindrance to the distribution of species. Every navigator is familiar with the fact that currents have a dividing power, shown by the tendency of objects to drift to the edge of the stream, although they may have fallen into the middle of it. This tendency of the current to clear itself—or clean itself—is stronger in proportion to its rapidity and strength. Hence, objects torn by a stream flowing between two islands from the one lying to the left of it, could be borne to that on the right side only under specially favoring circumstances; and *vice versa*, those brought from the right could never, or very rarely, be carried to the opposite side. Thus a mixture of the faunas of the two islands might be hindered, simply by the action of the current flowing between them, except in the case of free swimming animals having the power to overcome the mechanical resistance of the current. In considering the striking circumstance that the islands lying close to Africa have quite a different fauna from that of the neighboring continent, this influence is mentioned as a factor.

Between these theories, offered respectively by Mr. Wallace and Professor Semper, no positive conclusions can be drawn, for want of sufficient evidence based on general conclusions, and while neither can be rejected as erroneous, both must remain open for future discussion. Professor Semper, however, claims one advantage that his hypothesis appeals for proof only to such elements as can be brought under direct observation, while that of Mr. Wallace is intrinsically incapable of demonstration by observation.

The work concludes with sixty pages of closely-printed notes, containing much useful information, and a long array of facts bearing on the subject matter of the work.

We have probably shown by this review that Professor Semper has presented a work of the highest value to every naturalist, and we can assure the general reader that he will find in it material that will engross his attention, and cause him to regret the moment when he arrives at the last pages.

ERRATUM.

Mr. Dopp desires to make the following correction in his paper in the last issue:

"In my article on page 200 of "SCIENCE," the expression $\lambda = \frac{v}{n}$ and $\lambda' = \frac{v}{n'}$ should have been $\lambda = \frac{V}{n}$ and $\lambda' = \frac{V}{n'}$ V being the velocity of light.

SCIENCE

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